



APPENDIX J:

Draft Saltcedar Integrated Weed Management Plan for Stillwater NWR

[NEXT](#) [HOME](#)

Table of Contents

Introduction	J-1
Noxious Weed Status	J-1
Ecology of Saltcedar	J-2
Area Description	J-3
Goal and Objectives	J-4
Integrated Weed Management Strategies	J-5
Inventory and Monitoring	J-5
Control Methods	J-6
Reestablishing Native Vegetation Communities	J-9
Partnerships and Funding Needs	J-10
List of Potential Cooperative Partners	J-11
Literature Cited	J-12

List of Tables

Table I. Saltcedar Noxious Weed Status in Nevada, 2/5/98	J-2
Table II. Summary of Saltcedar Problems on U.S. Fish and Wildlife Service Lands Weed Survey, January 1996.	J-14
Table IV. Grants applied for by Stillwater NWR Complex to control saltcedar on the refuge.	J-10

Appendix J

Saltcedar Integrated Weed Management Plan
Stillwater National Wildlife Refuge Complex
Fallon, Nevada

Written by: _____

Anita Kang DeLong
Refuge Operations Specialist

Date: _____

Submitted by: _____

Kim Hanson
Refuge Manager

Date: _____

Reviewed: _____

Scott M. Stenquist
Reg. Integ. Pest/Weed Mgmt. Coord.

Date: _____

Approved: _____

Refuge Supervisor, ARW-CA/NV
Sacramento, CA

Date: _____

Assistant Regional Director,
Refuges and Wildlife
Portland, Oregon

Date: _____

[NEXT](#) [HOME](#) [BACK](#)

Saltcedar Integrated Weed Management Plan for Stillwater NWR Complex

Introduction

Saltcedar (*Tamarix* spp.) is a nonnative plant that was introduced to the United States from Eurasia during the late 1800s (Robinson 1958) and has spread throughout the southwestern United States. Saltcedar established on the Stillwater National Wildlife Refuge (NWR), Stillwater Wildlife Management Area and Fallon NWR, collectively the Stillwater NWR Complex, sometime prior to the 1950s. Flood and drought cycles have increased the distribution and abundance of saltcedar on the refuge complex, in addition to increased saltcedar along the Carson River watershed. Water delivery and storage in wetlands that benefit wildlife also often promotes seed distribution of saltcedar.

The Truckee-Carson-Pyramid Lake Water Rights Settlement Act (Title II of 101-618) directs that Stillwater NWR be managed for the purposes of: (1) maintaining and restoring natural biological diversity within the refuge; (2) providing for the conservation and management of fish and wildlife and their habitats within the refuge; (3) fulfilling the international treaty obligations of the United States with respect to fish and wildlife; and (4) providing opportunities for scientific research, environmental education, and fish and wildlife dependent recreation. P.L. 101-618 also authorizes revision of the Stillwater NWR boundary as may be appropriate to carry out the purposes of the refuge. The National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, requires that the biological integrity, diversity, and environmental health of the Refuge System be maintained. In addition, Executive Order 12996 (3/25/96) also emphasizes conserving and enhancing the quality and diversity of fish and wildlife habitat within refuges. The Federal Noxious Weed Act of 1975 (P.L. 93-629, 7 USC 280 1 et. seq.) authorizes the Secretary of Interior to cooperate with other Federal agencies, states, territories, districts, political subdivisions, farmer's associations, or similar organizations to eradicate, suppress, control, prevent, or retard the spread of any noxious weed. Although saltcedar is not a federally designated noxious weed, the Noxious Weed Act, amended in 1990, directs Federal agencies to enter into cooperative agreements with states to coordinate management of undesirable species on Federal lands.

Noxious Weed Status

Saltcedar is on the California noxious weed list but is currently not on the Federal noxious weed lists. These lists generally include weed species that are particularly troublesome to agriculture and have some likelihood of integrated weed management. However, it should be noted that the absence of saltcedar on such noxious weed lists does not mean that the plant is unmanageable or not a serious threat to native fish, wildlife, and plant species; livestock grazing; or other agricultural practices. Under the Federal Noxious Weed Act of 1975, the Secretary of Agriculture has the authority to designate plants as noxious weeds and to cooperate with other Federal, state and local agencies, farmer associations, and private individuals to control, eradicate, prevent, or retard the spread of such weeds. A 1990 amendment (Section 1453 under the Food, Agriculture, Conservation and Trade Act of 1990) included integrated management systems to control or contain undesirable plants targeted under cooperative agreements and establish and adequately fund the undesirable management program through the agency's budget process.

Saltcedar's invasive and persistent nature threatens natural biodiversity on Stillwater NWR. Biodiversity is defined as the variety of life and its processes, including the variety of living organisms, the genetic

Table I. Saltcedar Noxious Weed Status in Nevada, 2/5/98	
Federal (U.S.D.A., Animal Plant Health Inspection Service-Plant Protection and Quarantine [USDA-APHIS-PPQ])	State (Nevada Division of Agriculture)
No	No

differences among them, and the communities in which they occur (USFWS 1996c). Currently, saltcedar has infested refuge wetlands, riparian areas, water delivery system and desert uplands that were previously flooded. Loss of invaluable water through saltcedar transpiration is counter productive to maintaining healthy wetlands for wildlife. Salts accumulate in the soil from saltcedar leaf litter and the excretion of salt from its leaves which prevents the establishment of native plants. In addition, saltcedar slows water flow and increases sedimentation deposition in the refuge water delivery system, causing increased maintenance costs. Saltcedar has significantly altered plant-community structure in many marsh and riparian areas of the refuge complex. For instance, some primarily shallow-emergent marshes with graminoid shorelines are now increasingly monotypic tall-shrub communities of saltcedar. Expansive areas of former meadow communities composed of a diversity of grasses, rushes, and forbs are shifting to monotypic tall-shrub communities.

Saltcedar communities not only out competes native plants; they are less beneficial to wildlife than native plant communities. Angel-Wilson and Ohmart (1978) compared saltcedar communities and cottonwood-willow communities along the lower Rio Grande and found that cottonwood-willow communities supported greater densities of birds and higher bird species diversities than did saltcedar communities. On Stillwater NWR Complex, conversion of native plant communities to saltcedar stands would likewise affect the refuge's diversity of plants and animal species in wetland, playa, riparian and desert shrub upland communities. In addition, saltcedar negatively impacts the refuge's populations of threatened and endangered species which include the bald eagle and western snowy plover as well as species of concern such as the mountain plover, trumpeter swan, white-faced ibis, western least bittern, long-billed curlew, black tern, loggerhead shrike, Nevada viceroy, Great Basin spadefoot toad and northern leopard frog. These species historically occurred on Stillwater NWR Complex but some are now limited in their distribution and abundance.

This saltcedar-management plan addresses the Stillwater NWR goal to restore and maintain natural biodiversity by minimizing the distribution and abundance of saltcedar on the refuge. This plan provides a summary of saltcedar ecology, saltcedar management objectives, integrated weed management strategies, and saltcedar monitoring program for Stillwater NWR Complex.

Ecology of Saltcedar

Saltcedar depends on groundwater for its water supply and can use more than 9 acre-feet of water per acre per year (Robinson 1965). Saltcedar produces large quantities of seed from April to October that are disseminated by wind or water and remain viable for several weeks. The seeds will germinate on saturated soils or while afloat. Slowly receding water levels along river banks or wetland shoreline create optimum seed beds, but survival requires several months without subsequent flooding (Horton et al. 1960).

Once established, saltcedar is difficult to kill. Mature plants are tolerant of heat, cold, drought, flood, and high concentrations of dissolved solids (Everitt 1980). By dropping its leaves and halting growth, saltcedar can withstand lengthy droughts (Horton and Campbell 1974). Mature saltcedar can survive complete submergence for as long as 70 days (Warren and Turner 1975). Under saline conditions, saltcedar absorbs dissolved solids and exudes excess salts through glands in its leaves (Decker 1961). These salts are eventually deposited on the soil surface under the plant, sometimes forming a hard crust (McQueen and Miller 1972). This saline deposit continues to degrade the site and impedes the establishment of other vegetation. Saltcedar grows back vigorously after burning. If saltcedar is cut at or above ground level, the root crown will sprout vigorously. Severed stems and shoots readily root in moist soil and produce new plants. Adventitious roots sprout from submerged or buried saltcedar stems, and buried branches may also reproduce vegetatively (Merkel and Hopkins 1957 as cited by Kerpez and Smith (1987).

Area Description

The project area, which includes Stillwater NWR, Fallon NWR and Stillwater WMA, is approximately 160,000 acres. Currently saltcedar communities have primarily established along water delivery canals, the periphery of wetlands, and the Carson River and delta. The saltcedar acreage is continually expanding. The January 1996 National Weed Survey reported an estimated 1,000 acres of saltcedar on Stillwater NWR and 45 acres on Fallon NWR (Table II, page 15). During 1997, a ground survey of saltcedar was conducted at Stillwater NWR, Stillwater WMA and Fallon NWR to obtain a more accurate inventory of saltcedar on Stillwater NWR Complex. Although the survey was completed, the maps have yet to be made available in digital format and, therefore, saltcedar acreages are pending.

Saltcedar communities within the project area range from expansive, dense stands to isolated patches and single trees. Plant height ranges from seedlings only inches tall to trees of 25 feet. Average plant height for the majority of saltcedar on the project area is 7 feet.

Historical records document presence of saltcedar as early as 1950 (USFWS 1950). In 1950, USFWS reported that, "It has only been quite recently that we have recognized the full extent of tamarisk growth in the marsh area. Most of this growth is new, consisting of seedlings established in the past two years, and it does not show up except on close inspection of the marsh edges... The biggest problem area is Stillwater Point Reservoir and the channels distributing the Reservoir water... Tamarisk is widely distributed throughout the other parts of the marsh, but usually occurs only as individual, or small groups of plants. There is, though, a considerable growth in the Indian Lakes area particularly about one of the ponds receiving water from the Shoffner Drain." The report also mentioned 5 ½ acres between Foxtail Canal and the East Canal that contained saltcedar plants of various sizes from seedlings to bushes 6 to 9 feet tall.

The sporadic and relatively limited efforts to control saltcedar that have occurred over the last five decades have had little effect in curbing the spread of this species. In 1950, 2,4-D was sprayed to control saltcedar (USFWS 1950). Floods in the mid-1970s, 1980s, and again in late 1990s increased saltcedar distribution and abundance throughout the project area. Water management at Stillwater NWR that is beneficial to shorebirds, spring fill-up and receding water levels by late-summer, also allows for optimum saltcedar establishment.

Goal and Objectives

Although eradicating saltcedar from the project area is unrealistic at this time, a well designed and implemented saltcedar integrated weed management plan could effectively control this species within tolerable limits. Control methods that achieve an 80 to 90 percent kill of saltcedar plants will be considered successful based on criteria established for Kern and Pixley NWRs (USFWS 1996a) and results reported in Kerpez and Smith (1987). Follow-up control will be a necessary part of the management plan.

Goal:

Halt the expansion of saltcedar and reduce saltcedar to less than 15 percent of the vegetation cover within plant communities that contain saltcedar on Stillwater NWR, Fallon NWR, and Stillwater WMA .

Objectives:

1. Conduct a baseline inventory of saltcedar. Document the distribution, abundance, and size of saltcedar on the area and use the baseline saltcedar inventory as a standard from which to evaluate subsequent inventories. Saltcedar inventories will be repeated at a maximum of every 5 years.
2. Use mechanical, chemical, and/or inundation control methods to treat all of the priority areas within the next 15 years. Priority areas are areas on the refuge that have low densities of saltcedar stands, small/isolated patches of saltcedar and/or outlier saltcedar plants. The priority areas are generally located in the northern portion of the refuge (i.e., North Nutgrass, Nutgrass Road, north of North Road, Map 1) and are targeted to prevent the spread of saltcedar into pristine areas. Moderate density stands (Upper and Lower Foxtail, Dry Lake, Doghead, Cattail, Goose, East Alkali, South Nutgrass, West Nutgrass, Swan Check, Swan Lake) will be treated as time allows.
3. Continue to promote Stillwater NWR Complex as a release site of biological control insects, the leaf beetle (*Diorhabda elongata*), and strive to release the leaf beetles on the refuge within 5 years. Release of the leaf beetles will occur on sites that contain high density saltcedar stands (i.e., Lead Lake, North Tule, Stillwater Point Reservoir, D Line from North Paiute to Van Slough, Map 1).
4. Develop a monitoring program to track and evaluate the saltcedar control efforts on Stillwater NWR Complex. Adopt standardized saltcedar monitoring protocols and procedures developed by the US Fish and Wildlife Service Regional Office, USDA- Agricultural Research Service, and USDA-Animal Plant Health Inspection Service. Monitoring must occur to document pre- and post-effects of pest management (biological, chemical, mechanical, and inundation methods). Treatment data (i.e. treatment method, location, date, acreage, site characteristics) should be documented in a geographic information system (GIS) data base.
5. Develop on-the-ground vegetation restoration efforts to replace saltcedar with native, site-specific grasses, forbs, shrubs, and trees.

Integrated Weed Management Strategies

Integrated Weed Management (IWM) involves the use of several control techniques in a well-planned, coordinated, and organized program to reduce the distribution and abundance of saltcedar within the project area. Inventory and mapping is the first phase of this IWM program. The second phase includes prioritizing the management of weed problems, and choosing and implementing control techniques strategically (inundation, biological, chemical, and mechanical controls). The third phase is restoration of treatment sites with native vegetation and the fourth phase is the continued yearly treatment of saltcedar. Phases pertain to particular treatment sites, not the IWM program as a whole (e.g., while one site is in phase four, another site may be in phase two). Periodic monitoring using documented, replicable methods is critical to ascertain success/failure and to modify methods accordingly. The IWM program is a step-down management plan of the comprehensive conservation plan for Stillwater NWR Complex.

Inventory and Monitoring

The Service needs to be able to demonstrate and articulate failure and success of the integrated weed management plan. Survey methods need to be standardized and repeatable. The Service will explore cooperative efforts with U.S. Department of Agriculture (USDA)-Agricultural Research Service, USDA-Natural Resources Conservation Service and other entities to obtain aerial photographs of Stillwater NWR Complex. Saltcedar inventories will be repeated at a maximum of every 5 years and digitized into GIS - Arc Info.

A baseline inventory was conducted from February 25 to December 16, 1997 (Appendix A: 1997 Saltcedar Survey Notes). Saltcedar distribution was mapped on topographic maps by ground surveys. Saltcedar communities were characterized by describing dominant tree height and estimated age-class (seedling, sapling, young trees, and mature trees). Maps will be digitized and will serve as baseline data to compare to subsequent surveys. Periodic inventories will be conducted within 5-year intervals to assess changes in saltcedar distribution and abundance and assess results of the saltcedar management plan.

All treatment sites must be closely monitored to determine success of control methods. At a minimum, photo sites will be established and pre- and post-treatment photos taken at treatment sites. Documentation of treatment dates, area, control methods, post-control treatment methods, photo documentation and results must be maintained and stored in refuge files. Photo sites should be documented in this section on an attached map with a description on each photo of location and Universal Transverse Mercator (UTM) coordinates. Permanent photo sites should be marked on location with a rebar and metal tag with UTM coordinates. Photos should include a data reference point, photo taken toward some definite landmark that is not likely to change or move. The photo survey should be completed annually and maintained in a permanent refuge file.

Everitt et al. (1995) recommends the use of airborne video data with global positioning system technology for mapping and monitoring saltcedar. Everitt et al. described how Chinese tamarisk (*Tamarix chinensis*) could be distinguished from other plant species along riparian corridors in Arizona and Texas in late November when its foliage turned yellow-orange to orange-brown prior to leaf drop. This and other techniques for mapping saltcedar on the refuge are being investigated. Another option for mapping/monitoring saltcedar is obtaining satellite digital photos from Landsat which has a 30 meter pixel resolution. The cost was reasonable for images 1 year or older; however, the resolution (30 meter pixel)

was considered too large to capture saltcedar along water delivery canals and in areas of sparse saltcedar stands.

Control Methods

Mechanical Control Methods

Root plowing can be effective if the root crown of saltcedar plant is removed. The root plow must be at least 18 inches below the ground (Kerpez and Smith 1987) in order for the root crown to be severed. If the root crown is removed, lower roots will not sprout and form new plants (Horton 1960). The above-ground vegetation can be removed before or during root plowing, and should be piled and burned to prevent resprouting of shoots and stems. Root plowing during hot and dry weather (which promotes rapid drying of severed stems and shoots) will help prevent resprouting of unburned stems or shoots. Long, straight, and overlapping swaths should be root plowed to avoid missing plants (Kerpez and Smith 1987). Horton (1960) reported that root plowing killed more than 90 percent of saltcedar present. Kerpez and Smith (1987) considered this technique the most effective method available.

Prior to any mechanical control of saltcedar, a cultural resource survey would be completed for the proposed treatment area. Because cultural resources are prevalent within the project area, mechanical control methods may often be an inappropriate control method.

The following mechanical methods and procedures were developed and implemented at Bosque del Apache NWR and Kern NWR (USFWS 1996a) and should be considered for use at the Stillwater NWR Complex.

Medium - Large Dense Stands of Saltcedar on Flat Terrain

- M1. Tracked-dozer with blade attached, pulling wheel type high arch root rake. Equipment will knock down standing trees, rake and windrow trunks and limbs. Crisscrossing the area once is necessary before root plowing. Attached dozer blade will protect radiator from tree limbs.
- M2. Tracked-dozer with blade attached, pulling a root plow equipped with hydraulic rear arch attachment, to shear stumps below bud zone 18 to 24 inches deep and loosen soil for root raking. Attached dozer blade will help smooth surface and help protect radiator.
- M3. Repeat procedure M1 without crisscrossing the area root plowed, and windrow the woody debris.
- M4. Articulating 4WD wheel loader. Front bucket is replaced with heavy duty multi-application rake. This equipment consolidates windrowed woody debris into large piles relatively dirt free. Piles are left to dry two years to ensure a complete burn to ashes of all woody material.

Isolated Stands or Single Trees

- M5. Articulating 4WD wheel loader. Loader arms are mounted with a single tree gruber-stinger. This equipment is used in areas not possible or practical for root plowing and raking, and where trees are at the toe or on slopes of dikes.
- M6. Repeat procedure M4 under control of large dense areas to consolidate debris for burning. Multi-application rake is used to rake roots and buds from the ground.

Chemical Control Methods

Herbicides can be applied on the foliage, to the base of the plant, to the stump of cut plants, or to the root zone (Hollingsworth et al. 1973 and 1979). Application of herbicides to cut stumps kills more saltcedar than basal applications to live stems (Hughes 1965). Application of herbicides should occur when saltcedar is in full bloom or when leaves are in the growth stage (USFWS 1996b). There currently are three methods for applying herbicides on refuges to control saltcedar. Table III (page 17) summarizes these strategies (USFWS 1996b).

- C1. Aerially (helicopter) spray a mixture of 2 pints Arsenal, 6 pints Rodeo, 1 pint nontoxic surfactant, and 8.8 gallons of water per acre. This is referred to as a 10 gallon per acre mix. This method has been used at Bosque del Apache NWR, Ash Meadows NWR and numerous irrigation/water districts in the southwest. Saltcedar plants may take up to several years to die after treatment. Once dead, trees should be cut or knocked down with a dozer, stacked and then burned.

Advantages of Rodeo-Arsenal Mix are: (1) Arsenal enhances the ability of Rodeo to penetrate the physical structure of the leaf which increases the translocation of the Rodeo throughout the plant; (2) each product attacks three different amino acids of the plant, resulting in increased effectiveness; and (3) by cutting Arsenal with Rodeo, a significant cost reduction can be achieved without loss of effectiveness (USFWS 1994).

To date, Arsenal has not be registered for use over water, although certification is pending. Therefore, aerial application on Stillwater NWR would not be feasible unless the site is dry. Arsenal is registered in California and Nevada. Pending registration, an application for use can be submitted the State Department of Pesticide Regulation under their Research Investigation Authorization Procedures under Section 5, Experimental Use Permits, Federal Insecticide, Fungicide, and Rodenticide Act.

- C2. Spraying with high-volume, hand held, pressurized vehicle mounted equipment. The herbicide would be the same chemical mixture used in aerial application. For the herbicide to kill a tree, the entire foliage must be sprayed. This method could be used to treat single or isolated stands of trees. Again, once treated it could take several years for all the trees to die. Again, trees may need to be downed, stacked and burned.
- C3. Spraying with low-volume, hand held equipment. The herbicide used is 1 quart of Garlon 4 per 1 gallon of water. This herbicide would be applied to the remaining stumps following cutting with a chainsaw or rotary brush cutter. Leave a 12 to 18 inches stump above ground to allow for a wheel loader with clam shell to pull up individual trees. The herbicide mixture must be **applied immediately** (within seconds of cutting). Kern and

Pixley NWRs (USFWS 1996a) reported 80 to 85 percent kill mortality with no regrowth. This method requires large amounts of man-hours and therefore impractical for large areas of saltcedar unless volunteer labor, youth employment groups, or prison work parties are available. In any case, state pesticide certification and licensing are required for employees using pesticides.

Inundation

Long-term submergence will kill saltcedar (Kerpez and Smith 1987). Kerpez and Smith (1987) recommend removing above-ground portion of saltcedar before inundating. If plants are not removed, completely submerge them for at least 70 days (Warren and Turner 1975). Inundation has been effective at Stillwater NWR against saltcedar seedlings less than 10 inches tall or young plants that are mowed prior to inundation. Seedlings will be killed within a couple of weeks if completely submerged (Henry 1998).

Biological Control Insects

Currently, the biological control insect that appears the most promising is the leaf beetle (*Diorhabda elongata*) which is native to the People's Republic of China and is cold tolerant. Biological control investigative and operational work is being done by USDA - Agricultural Research Service (Dr. Jack DeLoach, Principal Research Scientist) and USDA-Animal Plant Health Inspection Service (Richard Gaspari and Juli Gould) for Saltcedar Biological Control .

A draft biological assessment was completed (DeLoach and Tracy 1997) and the information was used in an environmental assessment, in compliance with National Environmental Policy Act, for the proposed controlled release of the leaf beetle to test sites in Nevada, California, New Mexico, Texas, Arizona, Wyoming, and Colorado. The U.S. Fish and Wildlife Service offices in Las Vegas, Nevada, Carlsbad, California, Grand Junction, Colorado, and Cheyenne, Wyoming reviewed the draft biological assessment and prepared their biological opinion on possible impacts on the Federal endangered southwestern willow flycatcher (*Empidonax traillii eximius*) under the Federal Endangered Species Act. The U.S. Dept. Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA-APHIS-PPQ) draft environmental assessment on the saltcedar leaf beetle was available for public comment from March 18 to June 4, 1999. The environmental assessment and Finding of No Significant Impact were issued after the public comment period closed.

The USDA-APHIS-PPQ began to issue permits (USDA-APHIS-PPQ Form 526, Permit to Move Nongenetically Engineered Live Plant Pests or Noxious Weeds) for the release of the saltcedar leaf beetle, *Diorhabda elongata*, into field cages on July 8, 1999 at a total of ten sites in six states, including the Lovelock, Nevada area (Stillwater NWR, the Fallon Paiute-Shoshone Indian Reservation and the Walker River Paiute Indian Reservation). The release of the saltcedar leaf beetle onto Stillwater NWR Complex is subject to the approved environmental assessment and Finding of No Significant Impact to be completed by the Service. Stillwater NWR staff are currently working on the environmental assessment.

Annual monitoring of saltcedar abundance and density, along with other invasive species, is important at Stillwater NWR Complex. Monitoring of the saltcedar leaf beetle is also extremely critical to the station's saltcedar management effort. Monitoring was required by the Service in its revised condition of approval,

dated June 15, 1999, under authority of the Federal Endangered Species Act in comments to USDA-APHIS-PPQ for release of the saltcedar leaf beetle into cages.

Fire

Burning can be beneficial in saltcedar management if performed at the proper time with post-fire herbicide or other treatment of saltcedar resprouts (Jorgensen, 1996). Fire can be used to reduce saltcedar depending on the timing of the burn; fire-behavior, -intensity, and -management, and follow-up efforts. While fire destroys above-ground plant matter, saltcedar vigorously resprouts making herbicide treatment an important component of post-wildfires or -prescribed burns. Saltcedar will invade after a burn, so follow-up herbicide treatment along with re-establishment of native vegetation is essential. Optimum conditions for prescribed burning of saltcedar seem to be during the summer and fall, and include stand maturity greater than 4 years old, low dead-fuel moisture, and abundant litter in the summer or fall (Bureau of Reclamation 1995). A Fire Management Plan (Appendix K: Draft Fire Management Plan) for Stillwater NWR Complex will be developed for prescribe burning and suppressing wild fires.

Wild fires may provide the opportunity to rehabilitate saltcedar stands where conditions for prescribed fire seldom occur because of smoke management, crew and equipment availability, landowner or agency agreement, or other constraints. A “wildfire rehabilitation plan” will be written and approved in order for national wildfire funding to be used to restore the site to pre-wildfire conditions. As with prescribed burns, the objective of using wildfires is to cause minimum disturbance to the site’s native soil, water, and other characteristics while removing the saltcedar vegetation. Site monitoring, revegetation with native species, and post-treatment of regrowth of saltcedar and other noxious weeds is essential. Otherwise, saltcedar and other noxious weeds will reinvade the burned site.

Reestablishing Native Vegetation Communities

Comprehensive saltcedar management requires initial treatment, post-control treatment of saltcedar resprouts and seedlings, project monitoring, and the reestablishment of native vegetation. During this integrated weed management process, it is important to treat existing and invading exotic herbaceous annuals and perennials, in addition to saltcedar, while minimizing impacts to native vegetation (non-target species). The loss of mycorrhizal fungi and the other beneficial soil organisms favors exotic, nonnative species (St. John 1996). St. John (1996) noted that mycorrhizal fungi can be applied through the addition of top soil to a site or by subsurface incorporation/injection of commercial mycorrhizal inoculum.

Passive restoration is the preferred method of reestablishing cattail and bulrush in wetland units. However, desert upland sites and riparian sites may require active revegetation efforts. Desert upland sites may require plantings of desert shrubs such as greasewood, shadscale, spiny hopsage and rabbitbrush, depending on site potential, if native recolonization is unexpected or slow. Riparian sites along the Carson River and Stillwater Slough may require plantings of cottonwood, willow, wild rose, buffaloberry and other native shrub species.

Planting techniques used for revegetating farmland, acquired through the Water-Rights Acquisition Program, with native vegetation will be applied to reestablishing native vegetation communities after saltcedar treatment. Two techniques have been used successfully to date to revegetate abandoned farmland: shrubs planted in containers and seeds drilled into the ground. In the shrub planting technique, seeds were collected at Stillwater NWR from greasewood, rabbitbrush and saltbush and grown in

containers by the Nevada Division of Forestry nursery. Future plantings should also include other native species such as shadscale, and spiny hopsage. Planting sites were pre-irrigated and irrigated once after planting. Plantings at the DeBraga tract occurred in June and July, 1992 by hand planting, but future plantings should be conducted in the fall when more moisture is available to plants. Cost was approximately \$54 per acre. For the seed drilling technique, a native grass/shrub seed mixture at 5 to 6 pounds per acre was drilled in the fall and flood irrigated once after planting and once in the spring (McDonald tract). Seed mixture contained alkali sacaton, Great Basin wildrye, western wheatgrass, four-wing saltbush, quailbush, and gooseberry leaf globemallow. Cost for the planting was approximately \$40/acre.

Partnerships and Funding Needs

Saltcedar is not limited to the boundaries of the Stillwater NWR, Fallon NWR and Stillwater WMA; it is a problem species that has invaded the Lahontan Valley. Efforts to control saltcedar on the refuge will be unsuccessful in the long run if the problem is not addressed in a valley wide effort. Saltcedar seeds are transported, in part, via the Carson River and the irrigation water delivery system. Establishment of saltcedar in pastures reduces the livestock grazing potential of these areas. Saltcedar in the irrigation delivery system hinders the movement of water and allows for sedimentation deposition, increasing operational costs. Saltcedar establishment in the Carson River not only increases the potential for flooding but also out-competes the native cottonwood community and negatively impacts dependent wildlife. Saltcedar's voracious consumption of groundwater in this desert climate negatively effects all residents of Lahontan Valley.

Control of saltcedar and restoration back to native grasses, shrubs, and trees require people, equipment, and materials. In 1996, Bosque del Apache estimated the costs of mechanical saltcedar control at \$521 per acre and estimated costs for Stillwater NWR are expected to be similar.

Table IV. Grants applied for by Stillwater NWR Complex to control saltcedar on the refuge.

Grant Organization	Project Title	Date	Funding Requested	Proposed Partnership Matching Contribution	Status	Project Description
National Fish and Wildlife Foundation	Saltcedar Control Project	11/97	\$20,000	\$31,000	denied	Restore native wetland habitat by controlling saltcedar using mechanical and chemical methods. (100 acres)
National Fish and Wildlife Foundation	Sensitive Plant Survey & Vegetation Inventory	1/97	\$10,000	\$12,860	denied	Conduct a sensitive plant survey and inventory upland and exotic plant communities. (160,000 acres surveyed)

List of Potential Cooperative Partners

Churchill County
Churchill County Mosquito Abatement District
Ducks Unlimited
Fallon Paiute-Shoshone Tribe
Lahontan Conservation District
Natural Resource Conservation Service
Naval Air Station - Fallon
Nevada Division of Agriculture
Nevada Division of Wildlife
Nevada Native Plant Society
Nevada Natural Heritage
Private Landowners
Sierra Club
Stillwater Conservation District
The Nature Conservancy

U.S. Department of Agriculture
Agricultural Research Service
Animal Plant Health Inspection Service,
Plant Protection and Quarantine
Natural Resource Conservation Service
U.S. Department of Interior
Bureau of Indian Affairs
Bureau of Land Management
Bureau of Reclamation
Fish and Wildlife Service
Geological Survey, Biological Resources
Division
National Park Service
University of Nevada, Reno

Literature Cited

- Angel-Wilson, R.W., and R.D. Ohmart. 1978. Floral and attendant faunal changes on the lower Rio Grande between Fort Quitman and Presidio, Texas. Pages 139-147 in R.R. Johnson and J.F. McCormick, eds. Strategies for protection and management of floodplain wetlands and other riparian ecosystems. U.S. For. Serv., Gen. Tech. Rep. WO-12. 410pp.
- Bureau of Reclamation. 1995. Vegetation management study, Lower Colorado River. Phase II. Bureau of Reclamation, Boulder City, NV. 72 pp.
- Decker, J.P. 1961. Salt secretion by *Tamarix pentandra pall.* For Sci. 7:214-217.
- DeLoach, C.J. and J. Tracy. 1997. Effects of biological control of saltcedar (*Tamarix ramosissima*) on endangered species, biological assessment. Draft, U.S. Dept. Agr., Agr. Res. Ser., Temple, TX. 458 pp. plus appendices.
- Everitt, B.L. 1980. Ecology of saltcedar - a plea for research. Environ. Geol. 3:77-84.
- Everitt, J.H., D.E. Escobar, M.A. Alaniz, M.R. Davis, and J.V. Richerson. 1995. Using spatial information technologies to map Chinese tamarisk (*Tamarix chinensis*) infestations. Weed Sci. 44:194-201.
- Henry, William. 1998. Wildlife Biologist, Stillwater NWR, USFWS, Fallon, NV. Personal communication.
- Hollingsworth, E.B., P.C. Quimby, and D.C. Jaramillo. 1973. Root plow herbicide application as a new incorporation technique. Weed Sci. 21:128 - 130.
- , -----, -----, 1979. Control of saltcedar by subsurface placement of herbicides. J. Range Manage. 34:288-291.
- Horton, J.S. 1960. Use of a root plow in clearing tamarisk stands. U.S. For. Serv., Rocky Mt. For. Range Exp. Stn., Res. Note 50. 6 pp.
- Horton, J.S., and C.J. Campbell. 1974. Management of phreatophyte and riparian vegetation for maximum multiple use values. U.S. For. Serv., Res. Pap. RM-117. 23 pp.
- Horton, J.S., F.C. Mounts, and J.M. Kraft. 1960. Seed germination and seedling establishment of phreatophyte species. U.S. For. Serv., Rocky Mt. For. Range Exp. Stn., Stn. Pap. 48. 26 pp.
- Hughes, E.E. 1965. Basal and stump sprays for control of saltcedar (*Tamarix pentandra*). Weeds 13:338-340.
- Jorgensen, M.C. 1996. The use of prescribed fire and mechanical removal as means of control of tamarisk trees. Pages 28-29 in: Bell, C.E., Ed. 1996. The Saltcedar Management Workshop. Proceedings of the Saltcedar Management Workshop. June 12, 1996. Rancho Mirage, CA. 61 pp.

- Kerpez, T.A. and N.S. Smith. 1987. Saltcedar Control for Wildlife Habitat Improvement in the Southwestern United States.
- Merkel, D.L., and H.H. Hopkins. 1957. Life history of saltcedar. Trans. Kans. Acad. Sci. 60:360-369.
- McQueen, I.S., and R.F. Miller. 1972. Soil-moisture and energy relationships associated with riparian vegetation near San Carlos, Arizona. U.S. Geol. Surv., Prof. Pap. 655-E. 51pp.
- Robinson, T.W. 1958. Phreatophytes. U.S. Geol. Surv. Water-Supply Pap. 1423. 85pp..
- 1965. Introduction, spread, and areal extent of saltcedar (*Tamarix*) in the Western States. U.S. Geol. Surv., Prof. Pap. 491 - A. 12pp.
- St. John, T. 1996. Establishing a functional riparian community after saltcedar removal. Paper given at: Saltcedar Management and Riparian Restoration Workshop, Sept. 17-18, 1996, Las Vegas, NV. Refuge Operations, U.S. Fish and Wildlife Service, Portland, OR.
- USFWS (U.S. Fish and Wildlife Service). 1950. Stillwater Wildlife Management Area Narrative Report. May- Aug. Unpubl. report in refuge file, Stillwater National Wildlife Refuge, Fallon, NV. 39pp.
- USFWS 1994. Pest control proposal for saltcedar in the Carson Slough drainage. Unpublished refuge report. Ash Meadows NWR, Pahrump, NV. 4pp .
- USFWS 1996a. Saltcedar control proposal for Kern and Pixley NWRs. Unpublished refuge report. Kern NWR, Delano, CA. 22pp.
- 1996b. Draft, Saltcedar management strategy. ARW-OPR, Portland, OR. 23 pp.
- 1996c. Fish and Wildlife Service Manual.
- Warren, D.K., and R.M. Turner. 1975. Saltcedar (*Tamarix chinensis*) seed production, seedling establishment, and response to inundation. J. Ariz. Acad.. Sci. 10:135-144.

Table II. Summary of Saltcedar Problems on U.S. Fish and Wildlife Service Lands Weed Survey, January 1996.

State	National Wildlife Refuge (including coordination and wildlife mgmt. areas)	Saltcedar Spp. <i>Tamarix</i>	Acres Affected
ARIZONA			
	Bill Williams	<i>chinensis</i>	1,900
	Gilla River Waterfowl Management Area	<i>chinensis</i>	4,830
	Kofa	<i>ramosissima</i>	5
	San Bernardino	<i>chinensis</i>	1
ARIZONA, CALIFORNIA (Colorado River)			
	Cibola	<i>chinensis</i>	10,000
	Havasu	<i>chinensis</i>	6,000
	Imperial	<i>chinensis</i>	7,000
CALIFORNIA			
	Bitter Creek	<i>ramosissima</i>	200
	Coachella Valley	<i>chinensis</i>	10
	Kern	spp.	3,080
	Pixley	spp.	10
	Sacramento River	<i>ramosissima</i>	50
	Salton Sea	<i>chinensis</i>	500
	Sweetwater Marsh	spp.	2
	Tijuana Slough	spp.	270
COLORADO			
	Browns Park	spp.	75
MONTANA			
	Charles M. Russell	<i>ramosissima</i>	100
NEBRASKA			
	North Platte	<i>ramosissima</i>	1
NEW MEXICO			
	Bitter Lake	<i>ramosissima</i>	5,000
	Bosque del Apache	<i>chinensis</i>	4,000

Table II. Summary of Saltcedar Problems on U.S. Fish and Wildlife Service Lands Weed Survey, January 1996.

State	National Wildlife Refuge (including coordination and wildlife mgmt. areas)	Saltcedar Spp. <i>Tamarix</i>	Acres Affected
	Dexter National Fish Hatchery	<i>chinensis</i>	150
	San Andres	<i>chinensis</i>	16
	Sevilleta	<i>chinensis</i>	8,600
NEVADA			
	Amargosa Pupfish Research Station	<i>ramosissima</i>	1
	Ash Meadows	<i>aphylla</i>	30
	Ash Meadows	<i>ramosissima</i>	400
	Fallon	<i>ramosissima</i>	45
	Marble Bluff Fish Research and Control Station	<i>ramosissima</i>	1
	Moapa Valley	<i>ramosissima</i>	5
	Pahranagat	<i>ramosissima</i>	200
	Stillwater	<i>ramosissima</i>	1,000
OKLAHOMA			
	Salt Plains	<i>gallica</i>	4,000
TEXAS			
	McFaddin	<i>chinensis</i>	1
UTAH			
	Bear River Migratory Bird Refuge	<i>ramosissima</i>	10
	Fish Springs	spp.	777
	Ouray	<i>ramosissima</i>	1,340
WASHINGTON			
	Saddle Mountain	<i>ramosissima</i>	1
WYOMING			
	Seedskaelee	spp.	5
	Sub-total	<i>T. aphylla</i>	30
	Sub-total	<i>T. chinensis</i>	43,008
	Sub-total	<i>T. gallica</i>	4,000

Table II. Summary of Saltcedar Problems on U.S. Fish and Wildlife Service Lands Weed Survey, January 1996.

State	National Wildlife Refuge (including coordination and wildlife mgmt. areas)	Saltcedar Spp. <i>Tamarix</i>	Acres Affected
	Sub-total	<i>T. ramosissima</i>	8,359
	Sub-total	<i>T. spp.</i>	4,219
	Total		59,616

Saltcedar summary table on FWS lands, 1/96-Weed Survey, All Regions, Regions 1, 2, 6